2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 THE ATLAS CORPORATION PROPOSAL

2.1.1 Overview

The Atlas tailings pile is about 0.8 km (0.5 mile) in diameter and rises to an elevation of 1237 m (4058 ft) amsl. The height of the pile is about 27 m (90 ft) above the surface of the river terrace, which is approximately 1210 m (3970 ft) amsl at the side of the pile nearest the river. The pile is located 3.7 km (2.3 miles) northwest of Moab and occupies about 53 ha (130 acres) of land. The base of the pile is approximately 230 m (750 ft) from the Colorado River (Figure 2.1-1) at the closest point. The pile consists of an outer compacted embankment of coarse tailings and an inner impoundment of both coarse and fine tailings. An interim cover of uncontaminated earth covers the tailings. The amount of tailings is estimated to total 9.5 million metric tons (10.5 million tons). The water content of the tailings was reduced to the extent feasible by pumping water from wells in the tailings and spraying the water into the air at the top of the pile to promote evaporation. Moab Wash, an ephemeral stream channel, is located along the north and northeast sides of the tailings pile, while S.R. 279 and a bluff border the southwest side of the pile. Debris from the dismantlement of the mill buildings and associated structures has been placed in an area at the toe of the pile and covered with contaminated soils and fill.

Under the Atlas proposal, the tailings pile would be reclaimed at its current location. Rock riprap and clay required for covering the pile would be transported by truck to the site from proposed borrow areas located southeast of Moab in Spanish Valley for cobble-sized rock and gravel, southwest of the Atlas pile near the Moab Salt and Potash Production and Packaging Facility for larger rock, and northwest of Moab on Klondike Flat (i.e., a portion of the Plateau site) for clay.

2.1.2 Proposed Tailings Disposal on the Atlas Site

2.1.2.1 Final Structure and Characteristics of the Reclaimed Tailings Pile

Pile Design. The pile design proposed by Atlas was the subject of a detailed review as part of the final TER review process (NRC 1997). Additional modifications to the design may result from the ongoing review of the groundwater CAP. As proposed by Atlas, the reclaimed tailings pile at the Moab site (Figure 2.1-1) would be approximately 0.8 km (0.5 mile) in diameter and 27 m (94 ft) high at its highest point near the river. It would have sloped sides and a concave upper surface with drainage ditches (Figure 2.1-2). The pile would contain about 9.5 million metric tons (10.5 million tons) of tailings. In addition, miscellaneous materials including debris from mill decommissioning was disposed adjacent to the pile's southeastern edge. Atlas proposed that the currently relatively steep slopes on the sides of the pile would be reduced to 30 percent [i.e., 0.9 m (3 ft) vertical per 3 m (10 ft) horizontal] except at the eastern sides of the pile facing the river, where the slopes would be 10 percent. The top and sides of the pile would be covered with rock riprap layers. The elevation at the base of the pile is about 1210 m (3970 ft) amsl, and the highest spots on the outer rim of the reclaimed pile would be about 1238 m (4062 ft) amsl.

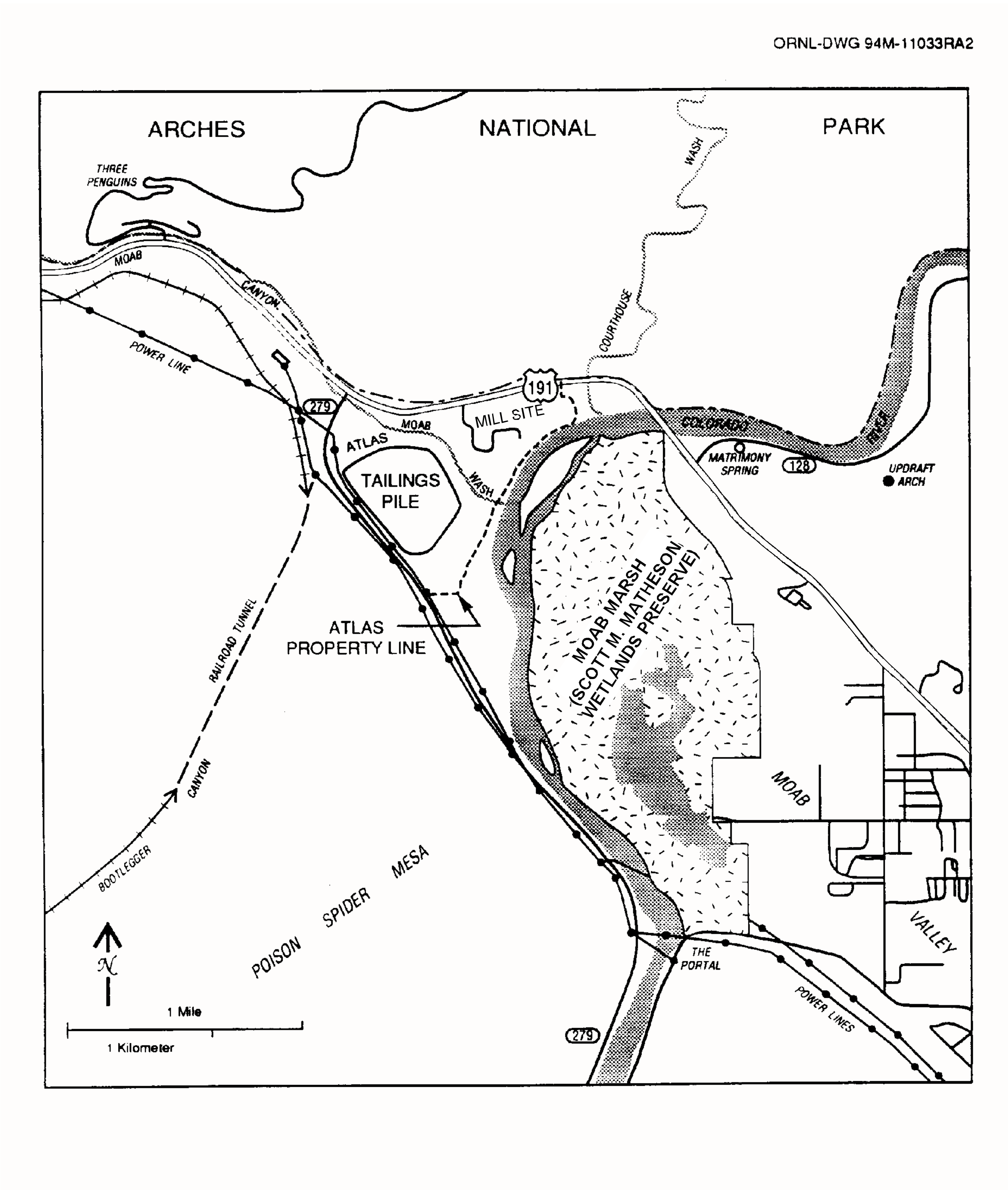

Figure 2.1-1. The Atlas Corporation Site and Uranium Mill Tailings Pile at Moab, Utah.

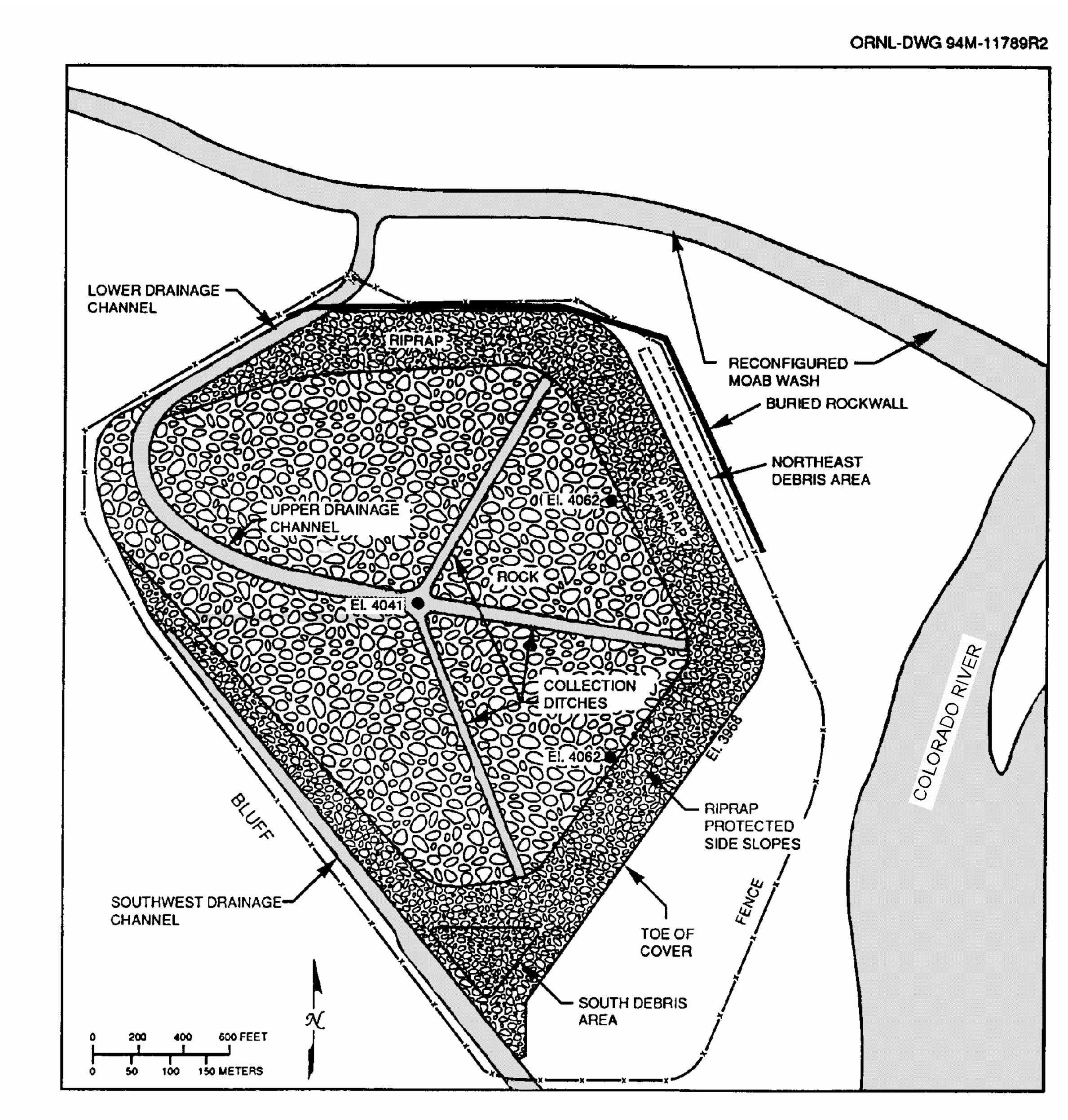

Figure 2.1-2. Proposed Surface Structure and Drainage for the Reclaimed Tailings Pile. El. = elevation in feet (divide by 3.281 to obtain meters). *Source*: Redrawn after Drawing No. 88-067-E95, Smith Technology Corporation 1996.

The reclaimed pile would be designed to minimize erosion, infiltration of rain water into the tailings, and the release of radon gas. The pile would be designed to withstand the probable maximum precipitation event and the probable maximum flood (PMF) event. Rock for riprap would have acceptable durability to withstand the forces of weathering. The design would comply with Criterion 6 of 10 CFR Part 40, Appendix A, which states that the design must provide reasonable assurance of control of radiological hazards to be effective for 1000 years to the extent reasonably achievable and, in any case for 200 years. The layers of the reclaimed pile, from the bottom upward, would include the tailings layer and a cover system (Table 2.1-1 and Figure 2.1-3).

The cover system would provide a minimum of 94 cm (37 inches) of cover above the tailings on the tops and sides of the cell. Generally, the cover would include a layer of affected soil from the mill area and outlying areas directly over the tailings, then a clay layer (radon barrier), a layer of sandy soil, and a surface layer of riprap. As currently proposed, the side slopes of the pile would not have a clay layer. However, if review of the revised groundwater CAP reveals the need to further reduce infiltration into the pile, a clay layer on the side slopes may be needed. If necessary to meet surface contour requirements, fill material may be placed in certain low areas over the coarse tailings prior to placing the cover system. The radon barrier would consist of suitable material to minimize both the escape of radon and infiltration of rain water. The rock, which would be at least 10 cm (4 inches) thick, would protect against erosion and restrict the intrusion of vegetation and burrowing animals into the radon barrier. Tailings include both coarse and fine tailings, with the latter having higher radiation levels.

Table 2.1-1. The Proposed Cover Profile Over Coarse Tailings, Fine Tailings, and Embankments[a]

	Over coarse tailings	Over fine tailings	On embankments
(bottom)	Low-grade ore from the mill area—15 cm (6 inches)	Regraded coarse tailings—2.1 m (7 ft) minimum	Regraded coarse tailings
	Affected soil—41 cm (16 inches)	Affected soil—41 cm (16 inches) minimum[b]	Sandy soil—2.1 m (7 ft) minimum
	Compacted clay— 20 cm (8 inches) minimum	Compacted clay—30 cm (12 inches) minimum	Filter layer—variable thickness
	Sandy soil—23 cm (9 inches)	Sandy soil—23 cm (9 inches) minimum	
(top)	Rock—variable thickness	Rock— variable thickness	Rock—variable thickness

[a]Final TER (NRC 1997).

[b]Affected soil is soil that must be removed from the mill area and outlying areas to meet cleanup standards. Ore is waste rock-like material that was mined and transported to the mill. All indicated thicknesses of layers are minimums.

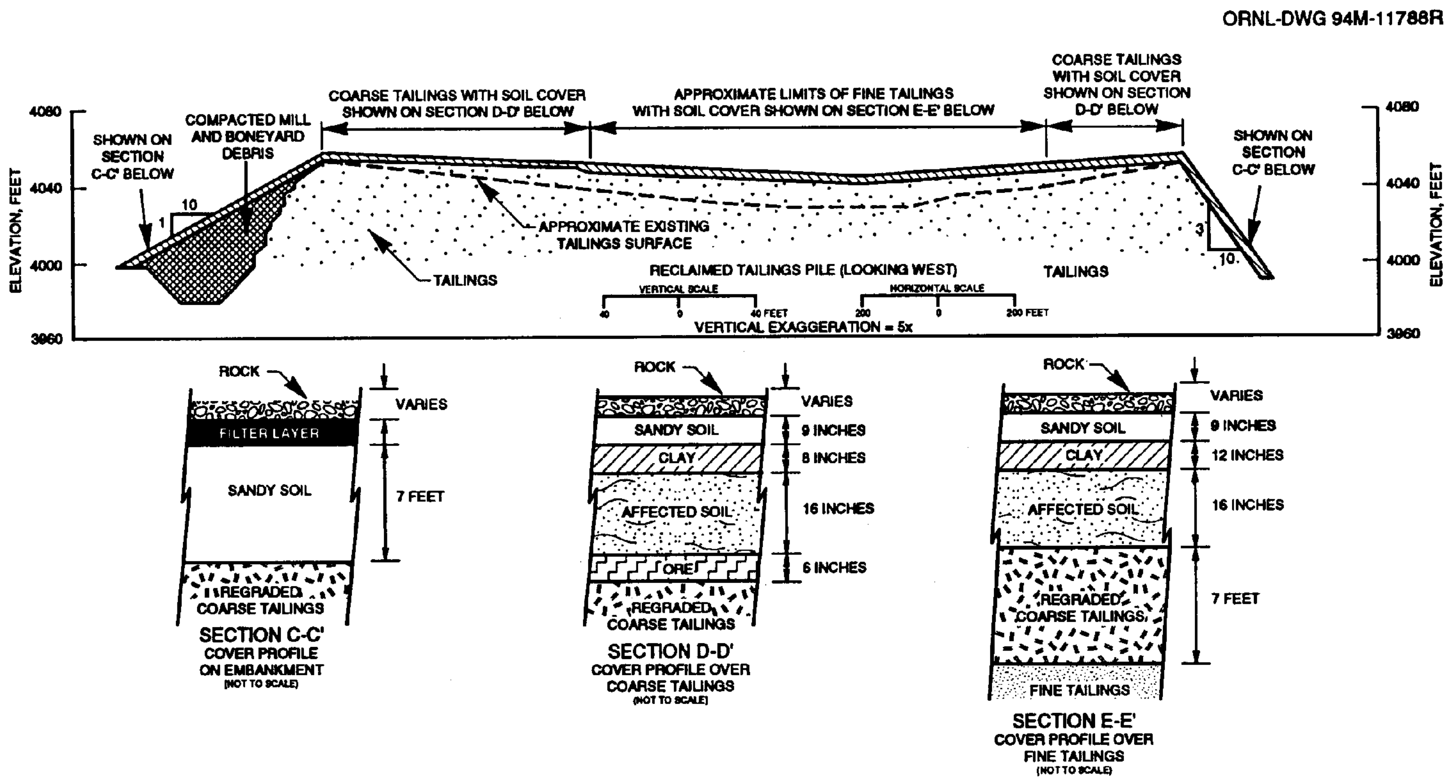

Figure 2.1-3. Proposed Interior Structure of the Reclaimed Tailings Pile. The view is toward the west. *Source*: Redrawn from Drawing No. 88-067-E19, Smith Technology Corporation 1996.

As shown in Table 2.1-1, a thicker cover system over fine tailings would be required to meet radon emission limits. The placement of coarse tailings over any fine tailings currently at the surface is proposed.

The relatively flat top of the pile would be sloped slightly downward toward the middle and toward the northwest to promote collection of surface runoff and drainage to Moab Wash. Surface runoff on the top of the pile would flow to several collection ditches that would direct rainwater to a channel leading from the top of the pile to Moab Wash (Figure 2.1-2). Another ditch would be constructed between the bluff and the southwest slope of the tailings pile to convey runoff toward the Colorado River. All ditches would be protected with riprap and one or more layers of gravel under the riprap. The gravel layers are needed in the ditches to provide additional protection against erosion of the underlying soil material during runoff events. Moab Wash (Figure 2.1-1) would be rerouted in the vicinity of the pile to run through the former mill site area. The reconfigured channel would discharge into the river upstream of the current discharge point. Figure 2.1-2 shows the proposed route of the reconfigured channel. An inner channel about 0.6 m (2 feet) deep would be designed to carry runoff for a 200-year flood. Flood protection along the base of the pile would protect the pile from higher floods and the possibility of channel migration. Additional discussion of the design for flood protection of the pile is discussed in the final TER (NRC 1997). Material excavated during construction of the reconfigured channel would be used as cover material for the pile; any materials that were found to be contaminated would be placed on the tailings pile before the cover was installed.

At the toes (bases) of the side slopes, the riprap would be extended a minimum of 0.9 m (3 ft) beneath the earth surface to provide extra protection against flood erosion. Riprap would be extended 2.4 m (8 ft) below the surface at the outlets of the drainage ditches to prevent erosion (headcutting) of the outlets. In addition, the NRC could require any additional protection determined to be necessary as a condition of plan approval.

NRC has reviewed the sizes of riprap proposed by Atlas that would be used for erosion protection based on slope and exposure to runoff (Table 2.1-2) in the final TER and has found them to be acceptable (Section 4.5 of NRC 1997).

Characteristics of the Tailings. The majority of the ore for the Atlas Mill came from the Big Indian Uranium District approximately 129 km (80 miles) to the southeast. The ore was primarily a sandstone with minor amounts of carbonate. Other ores came from small private mines in other districts. Ore was trucked to the mill and ground to a sufficiently fine consistency to allow the most efficient chemical reactions for extraction of uranium. During early operations, Atlas utilized an acid leach process for uranium milling. During this period, lime was added to the mill tailings to help in neutralization of the tailings. In 1961 an alkaline leach process was initiated. A new acid leach circuit was installed in 1967, and both acid and alkaline circuits were operated. Only the acid leach process was used from 1982 through 1984, with no neutralization of process water because a water recycle process was in use.

Table 2.1-2. Riprap Sizes and Thickness

Location/Feature	D50[a] [cm (inches)]	Layer thickness [cm (inches)]
Upper top slope	3.3 (1.3)	10.2 (4)
Lower top slope (1V:10H)	7.6 (3.0)	15.2 (6)
Side slope (3V:10H)	13.5 (5.3)	26.7 (10.5)
Collection ditches	13.5 (5.3)	26.7 (10.5)
Upper tailings pile drainage channel	13.5 (5.3)	26.7 10.5)
Moab Wash channel	22.9 (9)	34.3 (13.5)
Southwest drainage channel	22.9 (9)	34.3 (13.5)
Apron along Colorado River	28.4 (11.2)	76 (30)
Southwest drainage channel	28.4 (11.2)	43 (17)
Lower tailings pile drainage channel	44.2 (17.4)	66 (26)
Lower southwest drainage channel (outlet)	70.1 (27.6)	106.7 (42)

[a]D50 median stone size.
Source: Table 4-4, final TER (NRC 1997).

After milling, the waste slurries from both circuits were combined and pumped to the tailings pile. The embankment consists of compacted coarse tailings (sands), whereas the impoundment has both fine tailings (slimes) and coarse tailings. Some unmilled ore is also present.

In 1987, as part of an independent assessment of the characteristics of the tailings, NRC obtained samples of the tailings liquid present in the pond at the top of the embankment to identify hazardous organic and inorganic constituents. Of the 132 organic constituents sampled, most had concentrations of 0.01 mg/L (ppm) or less, and all had concentrations less than 0.051 mg/L. Concentrations of inorganic constituents are shown in Table 2.1-3. A composite analysis of the tailings by Atlas determined that the average radium activities were as follows: slimes—47 Becquerels per gram (Bq/g) [1275 picocuries per gram (pCi/g)]; sands—8.9 Bq/g (241 pCi/g); and ore—7.9 Bq/g (213 pCi/g). Recent analyses of two cores taken through the pile (ORNL/GJ 1998a) were generally consistent with the composite analysis, with radium activities for slimes ranging from 27.7 to 76.8 Bq/g (748 to 2070 pCi/g) and for sands from 3.7 to 21.0 Bq/g (99.7 to 566 pCi/g). This study also included analyses of soil samples from the two cores taken through the pile to the underlying alluvium. The results of these analyses of metal content are shown in Table 2.1-4. The analysis of these cores demonstrated that the tailings are not within the alluvial aquifer, except for the possibility of very high river levels (ORNL/GJ 1998a).

Table 2.1-3. Chemical Composition of Tailings Liquid (*Source*: NRC 1987)

Constituent	Sample #1 Total (mg/L)	Sample #2 Total (mg/L)	Sample #1 Dissolved (mg/L)	Sample #2 Dissolved (mg/L)
Aluminum	450	420	200	450
Ammonia	–	–	2150	2400
Antimony	7.3	6.8	11	24
Arsenic	2.7 (1.7)[a]	2.6 (1.6)[a]	1.0 (0.72)[a]	1.8 (1.6)[a]
Barium	<0.50	<0.50	<0.20	0.25
Beryllium	0.14	0.13	0.062	0.14
Bicarbonate	–	–	<5	<5
Boron	<2.0	<2.0	<0.80	<0.80
Bromide	–	–	<500	<500
Cadmium	0.51	0.45	0.22	0.49
Calcium	280	250	130	310
Carbonate	–	–	<5	<5
Chloride	–	–	410	370
Chromium	1.6	1.4	0.70	1.3
Cobalt	1.4	1.3	0.61	1.3
Copper	11	11	5.1	11
Cyanide	–	–	<0.002	0.006
Fluoride	–	–	<100	<100
Gallium	<7.5	<7.5	<3.0	<3.0
Iron (Fe2)	610	560	270	650
Lead	<5.0	<5.0	<2.0	<2.0
Lithium	<5.0	<5.0	<2.0	3.7
Magnesium (Mg2)	520	490	230	500
Manganese	28	26	13	28

Table 2.1.3. Continued

Constituent	Sample #1 Total (mg/L)	Sample #2 Total (mg/L)	Sample #1 Dissolved (mg/L)	Sample #2 Dissolved (mg/L)
Mercury	<.0005	<.0005	<.0005	<.0005
Molybdenum	<1.0	<1.0	<0.4	0.52
Nickel	<1.5	<1.5	<0.60	1.1
Nitrate	–	–	<500	<500
Nitrite	–	–	<100	<100
Phosphate	–	–	<500	<500
Phosphorus	<7.5	<7.5	<3.0	5.1
Selenium	<5.0 (0.40)[a]	<5.0 (0.40)[a]	<2.0 (0.23)[a]	<2.0 (0.45)[a]
Silicon	7.3	6.8	11	24
Silver	<1.2	,1.2	<0.50	<0.50
Sodium (Na2)	1800	1600	800	1800
Strontium	3.7	3.5	1.7	3.6
Sulfate	–	–	26,000	30,000
Tin	<1.2	<1.2	<0.50	(0.50
Titanium	0.55	0.52	0.34	0.58
Uranium	17.7	17.0	4.0	8.9
Vanadium	54	50	24	53
Zinc	6.0	5.1	2.6	5.9
Zirconium	<0.50	<0.50	<0.20	<0.20
pH	–	–	2.17	2.19
Total dissolved solids (TDS)	–	–	22,800	23,900
Total suspended solids (TSS)	–	–	5	10

[a]Second sample results in parentheses.